EXHAUST VIBRATION DECOUPLING CONNECTOR WITH LOCKED LINER TUBES

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of application number 10/307,124, filed 11/26/2002.

BACKGROUND OF THE INVENTION

This invention relates to engine-exhaust connectors that employ bellows or bellows-functional apparatuses in combination with mesh-wire washers, gaskets, or other resilient and high-temperature absorbency spacers for decoupling that prevents transfer of exhaust vibration and noise to mufflers, smog-control and other exhaust-downstream devices.

Numerous bellows apparatuses are known for joining flexible conveyances. Many patents and other prior art could be cited.

For specificity of this invention, however, only one, U.S. Patent Number 6,086,110, granted to Lee, *et al.* on July 11, 2000 will be referenced in detail. There is no other prior art known to be sufficiently similar to merit anticipatory comparison. The Lee, *et al.* patent and this invention disclose most nearly the use of a bellows in combination with mesh-wire damping washers to decouple vibration of exhaust of an internal-combustion engine from exhaust-treatment devices and structures that include smog-control devices, mufflers and exhaust pipes. However, the combinations, structures, positional relationships, functional relationships, manufacturing requirements, attachment methods, costs, durability and effectiveness of bellows and mesh-wire washers of this invention and the Lee, *et al.* patent are all different.

Different structure and working relationship of parts of the Lee, *et al.* patent and this invention require different manufacturing and application features that set them apart additionally. The Lee, *et al.* patent requires welding, metal-work bending and tapering interspersed with machining and assembly. It is most suited to integrated production of an entire decoupling system in a single manufacturing facility. Production for the Lee, *et al.* patent is not readily segmental for outsourcing or competitive participation. It requires high-cost production with interspersed production methods and uses of machinery that inhibit competitive interests from encroachment into OEM or after-market business activities. Its high production cost can increase gross sales which increases profit which benefits its producer, but only as long as proprietary protection and business strength can be maintained adequately.

This invention, however, provides low-cost and easily segmented production that can be out-sourced readily. Also, it can be attached and detached quickly, easily and reliably to exhaust manifolds and to downstream exhaust-treatment, muffler and exhaust-pipe components.

Examples of most-closely related known but different devices are described in the following patent documents:

Patent No.		Inventor	Issue Date
US	6,086,110	Lee, *et al.*	07-11-2000
US	5,653,478	McGurk, *et al.*	08-05-1997
US	5,639,127	Davey	06-17-1997
US	5,506,376	Godel	04-09-1996
US	5,482,330	Holzhausen	01-09-1996
US	H1101	Waclawik	09-01-1992
US	247,591	White	09-27-1881
JP	2-129489		1990
EU	0 681 097 A1		02-06-1995
DE	33 21 382 A1		02-16-1984

SUMMARY OF THE INVENTION

Objects of patentable novelty and utility taught by this invention are to provide an exhaust-vibration decoupling connector which:

is flexible centrally and over a long area to increase use life;

is highly effective in isolating or decoupling exhaust vibration and noise from exhaust-related engine components;

has a locked liner tube to prevent failure caused by linear over extension;

can be manufactured at low cost;

has segmental production features that can be outsourced for competitive production;

can be assembled and attached to an exhaust system quickly and easily;

can have long use life; and

can be detached for maintenance and replacement quickly and easily.

This invention accomplishes these and other objectives with an exhaust-vibration decoupling connector having an inlet tube extended downstream from a decoupler inlet to a damper step. The damper step includes a radially inward extension of the inlet tube to a damper seat that includes further downstream extension of the inlet tube for seating a vibration damper. An outlet tube is extended upstream from a decoupler outlet to a damper restraint that includes a radially inward extension of the outlet tube to proximate an outside surface of the damper step. A vibration damper is positioned on the damper seat intermediate the damper step and the damper restraint at proximate midway between the decoupler inlet and the decoupler outlet. A decoupler bellows includes a bellows upstream connector

proximate an outside periphery of the inlet tube and a bellows downstream connector proximate an outside periphery of the outlet tube. The decoupler bellows has a plurality of convolutions intermediate the bellows upstream connector and the bellows downstream connector. Enclosing an outside periphery of the decoupler bellows can be a resilient sleeve that is extended from proximate the bellows upstream connector to proximate the bellows downstream connector. External to the resilient sleeve if used and external to the decoupler bellows is a cover sleeve that is extended from proximate the bellows downstream connector to a predetermined distance from the bellows upstream connector for rigid protection of the decoupler bellows and the resilient sleeve if used. The decoupler inlet is articulated for attachment to an exhaust-outlet structure on an engine. The decoupler outlet is articulated for attachment to an exhaust-treatment structure. The inlet tube may have a bend at an upstream end where it interconnects with a bend on a downstream end of the outlet tube to limit bellows extension due to linearly expansive forces that could cause failure of the connector.

The above and other objects, features and advantages of the present invention should become even more readily apparent to those skilled in the art upon a reading of the following detailed description in conjunction with the drawings wherein there is shown and described illustrative embodiments of the invention.

BRIEF DESCRIPTION OF DRAWINGS

This invention is described by appended claims in relation to description of a preferred embodiment with reference to the following drawings which are explained briefly as follows:

FIG. 1 is a partially cutaway side view of the invention having a flex cover and a cover shield external to a bellows that has flexibly parallel walls and has a vibration

damper that is a mesh-wire washer in a damper fixture midway between a decoupler inlet and a decoupler outlet;

FIG. 2 is a partially cutaway side view of the invention having the flex cover and the cover shield external to the a vibration damper that includes wave springs between wave-spring washers;

FIG. 3 is a partially cutaway side view of the invention without the cover shield external to the bellows and includes the vibration damper that is the mesh-wire washer in the damper fixture;

FIG. 4 is a partially cutaway side view of the invention without the flex cover and the cover shield external to the bellows and with a vibration damper that includes a helical spring; [[and]]

FIG. 5 is a partially cutaway side view of the invention with the flex cover and the cover shield external to the bellows that has vibration-damping material that can be mesh-wire washers in the undulations of the bellows and includes a vibration damper that is a spring-side damper in the damper fixture[[.]];

FIG. 6 is the **FIG. 1** view of the invention with a ninety degree locking bend on the inlet tube which interlocks with the outlet tube to provide a liner locked against linearly expansive forces; and

FIG. 7 is the **FIG. 1** view of the invention with a slanted locking bend on the inlet tube which interlocks with the outlet tube to provide a liner locked against linearly expansive forces.

DESCRIPTION OF PREFERRED EMBODIMENT

Listed numerically below with reference to the drawings are terms used to describe features of this invention. These terms and numbers assigned to them designate the same features throughout this description.

1. Inlet tube
2. Decoupler inlet
3. Damper fixture
4. Outlet tube
5. Decoupler outlet
6. Mesh-wire washer
7. Bellows
8. Parallel walls
9. Upstream bellows attachment
10. Downstream bellows attachment
11. Bellows inside perimeter
12. Undulations
13. Flex cover
14. Upstream flex attachment
15. Downstream flex attachment
16. Shield sleeve
17. Shield attachment
18. First undulation wall
19. Second undulation wall
20. First flex-cover wall
21. Second flex-cover wall
22. Inlet-tube step
23. Damper seat
24. Outlet-tube step/inward bend
25. Wave-spring damper
26. Wave-spring washers
27. Helical-spring damper
28. Spring-side damper
29. Helical spring
30. First wall
31. Second wall
32. Braid cap
33. Exhaust-outlet structure
34. Exhaust-treatment structure
35. Mesh-wire ring
36. 90° inlet tube locking bend
37. Slanted inlet tube locking bend

Referring to **FIG. 1**, an inlet tube **1** is extended downstream from a decoupler inlet **2** to proximate an upstream portion of a damper fixture **3**. An outlet tube **4** is extended upstream from a decoupler outlet **5** to proximate a downstream portion of the damper fixture **3**. The damper fixture **3** is proximate midway between the decoupler inlet **2** and the decoupler outlet **5**.

A vibration damper, which in this embodiment is a mesh-wire washer **6**, is positioned removably in the damper fixture **3**. A bellows **7**, with preferably parallel walls **8**, has an upstream bellows attachment **9** proximate the decoupler inlet **2**. The bellows **7** has a downstream bellows attachment **10** proximate the decoupler outlet

5. The bellows **7** has a bellows inside perimeter **11** that is radially outward predeterminedly from a radially outside perimeter of the mesh-wire washer **6** or other vibration damper. The bellows inside perimeter **11** is defined by inside peripheries of undulations **12** of the bellows **7**.

A flex cover **13** has an upstream flex attachment **14** proximate the decoupler inlet **2**. The flex cover **13** has a downstream flex attachment **15** proximate the decoupler outlet **5**. The bellows inside perimeter **11** is radially outward predeterminedly from a radially outside perimeter of the wire-mesh washer **6** or other vibration damper.

A shield sleeve **16** has a shield attachment **17** proximate the decoupler outlet **5**. The shield sleeve **16** has a shield inside perimeter that is positioned radially outward predeterminedly from a radially outside perimeter of the flex cover **13**.

The upstream bellows attachment **9** includes an upstream bellows sleeve extending downstream axially a predetermined attachment distance from proximate the decoupler inlet **2** to a first undulation wall **18** that is extended radially intermediate the upstream bellows sleeve and a first side of a first of the undulations **12** of the bellows **7**.

The downstream bellows attachment **10** includes a downstream bellows sleeve extending upstream axially a predetermined attachment distance from proximate the decoupler outlet **5** to a second undulation wall **19** that is extended radially intermediate the downstream bellows sleeve and a second side of a last of the undulations **12** of the bellows **7**.

The upstream bellows sleeve, shown at the upstream bellows attachment **9**, includes an inside periphery that is positioned on an outside periphery of a fastener portion of the inlet tube **1**. The downstream bellows sleeve, shown at the downstream

bellows attachment **10**, includes an inside periphery that is positioned removably on an outside periphery of a fastener portion of the outlet tube **4**.

The upstream flex attachment **14** includes an upstream flex-cover sleeve extending downstream axially a predetermined attachment distance from proximate the decoupler inlet **2** to a first flex-cover wall **20** that is extended radially intermediate the upstream flex-cover sleeve and a first attachment side of the flex cover **13**. The downstream flex attachment **15** includes a downstream flex-cover sleeve extending upstream axially a predetermined attachment distance from proximate the decoupler outlet **5** to a second flex-cover wall **21** that is extended radially intermediate the downstream flex-cover sleeve and a second attachment side of the flex cover **13**.

The upstream flex-cover sleeve includes an inside periphery that is positioned removably on an outside periphery of the upstream bellows sleeve. The downstream flex-cover sleeve includes an inside periphery that is positioned removably on an outside periphery of the downstream bellows sleeve.

The inlet tube **1** is circumferential with an inside perimeter and an outside perimeter. The outlet tube **4** is circumferential with an inside periphery and an outside periphery. The inside periphery and the outside periphery of the inlet tube **1** are predeterminedly smaller than the inside periphery and the outside periphery of the outlet tube **4**. The damper fixture **3** can include an inlet-tube step **22** extended radially inward to a damper seat **23** having an axial downstream extension of the inlet tube **1**. The damper fixture **3** can include an outlet-tube step **24** extended radially inward to predeterminedly proximate an outside periphery of the damper seat **23**. The inlet-tube step **22** includes a first side of the damper fixture **3** and the outlet-tube step **24** includes a second side of the damper fixture **3**.

The outlet-tube step **24** can be articulated to allow axial and pivotal travel of the outlet tube **4** in relation to the inlet tube **1** predeterminedly. To illustrate this

pivotal feature, the outlet-tube step **24** in **FIG. 5** is depicted to be arcuate proximate the damper seat **23**.

For the embodiments of this invention shown in **FIGS. 1** and **3**, the vibration damper includes the mesh-wire washer **6** having an inside periphery that is positioned removably on the damper seat **23**, an outside periphery that is predeterminedly smaller than the bellows inside perimeter **11**, a first side proximate the inlet-tube step **22**, and a second side proximate the outlet-tube step **24**.

For the embodiment shown in **FIG. 2**, the vibration damper includes one or more wave springs **25** that can include wave-spring washers **26** that are in detachably sealed contact with the inlet-tube step **22** and the outlet-tube step **24**.

For the embodiments shown in **FIG. 4**, the vibration damper includes a helical-spring damper **27**.

For the embodiment shown in **FIG. 5**, the vibration damper includes a spring-side damper **28** having a helical spring **29** in a circumferential channel with a first wall **30** adjacent to the inlet-tube step **22** and a second wall **31** adjacent to the outlet-tube step **24**. The circumferential channel is arcuate intermediate the first wall **30** and the second wall **31**. The first wall **30** and the second wall **31** have inside peripheries proximate the outside periphery of the damper seat **23**.

For the embodiments shown in **FIGS. 1- 5**, the flex cover **13** includes a heat-resistant and flexible material that is reinforced with wire network predeterminedly. The flex cover **13** can include a braided-wire material. The flex cover **13** can include a braid cap **32** that is positioned intermediate the upstream flex attachment **14** and predetermined exhaust-outlet structure **33** to which the exhaust-vibration decoupling connector is attachable.

As shown in **FIGS. 1-5,** the upstream bellows attachment **9** is articulated for sealed attachment to the predetermined exhaust-outlet structure **33**. The downstream bellows attachment **10** is articulated for sealed attachment to a predetermined exhaust-treatment structure **34** that is fluidly downstream from the exhaust-outlet structure.

The upstream bellows attachment **9** is disposed a snug-fit distance from the downstream bellows attachment **10** for fitting snugly intermediate the exhaust-outlet structure **33** and the exhaust-treatment structure **34** predeterminedly.

The exhaust-outlet structure **33** normally includes an exhaust flange of sorts. The exhaust-treatment structure **34** normally includes a conveyance tube or pipe from a smog-control device, a muffler or an exhaust pipe. The exhaust-outlet structure **33** also can include downstream connections for a smog-control device or muffler. These structures are shown figuratively without specificity of attachment structures for particular engines or exhaust-treatment devices.

For the embodiments shown in **FIGS. 1-2** and **5**, the shield sleeve **16** has a shield length that is less than the snug-fit distance for allowing axial distance change between the decoupler inlet **2** and the decoupler outlet **5** and for allowing pivotal movement of the decoupler outlet **5** predeterminedly.

For the embodiments shown in **FIGS. 1-5,** the bellows **7** includes flexibly parallel walls **8** intermediate arcuately flexible floors and roofs.

Referring to **FIG. 5**, the bellows **7** can include damping filler intermediate internal walls which include the parallel walls **8** of undulations **12**. The damping filler can include mesh-wire rings **35**.

<u>**FIGS. 6 and 7** show embodiments of the invention in which the inlet tube **1** has an outward radial bend, such as a ninety degree (90°) bend **36** or slanted bend **37**,</u>

respectively, which interlocks with an inward radially bend **24**, also called a step, on the outlet tube **4** so as to limit extension of the bellows **7** due to linearly expansive forces that may cause failure of the connector. This locking feature allows the device to experience only compressive movement and prevents the flex cover or braid **13** from handling linearly extensive expansion forces that could cause the device to break apart.

A new and useful exhaust-vibration decoupling connector having been described, all such foreseeable modifications, adaptations, substitutions of equivalents, mathematical possibilities of combinations of parts, pluralities of parts, applications and forms thereof as described by the following claims and not precluded by prior art are included in this invention.